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COMPOUND STIMULI IN EMERGENT STIMULUS RELATIONS: EXTENDING THE SCOPE OF STIMULUS EQUIVALENCE

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Three experiments were conducted to investigate stimulus relations that might emerge when college students are taught relations between compound sample stimuli and unitary comparison stimuli using match-to-sample procedures. In Experiment 1, subjects were taught nine AB-C stimulus relations, then tested for the emergence of 18 AC-B and BC-A relations. All subjects showed the emergence of all tested relations. Twelve subjects participated in Experiment 2. Six subjects were taught nine AB-C relations and were then tested for symmetrical (C-AB) relations. Six subjects were taught nine AB-C and three C-D relations and were then tested for nine AB-D (transitive) relations. Five of 6 subjects demonstrated the emergence of symmetrical relations, and 6 subjects showed the emergence of transitivity. In Experiment 3, 5 college students were taught nine AB-C and three C-D relations and were then tested for nine equivalence (D-AB) relations and 18 AD-B and BD-A relations. Three subjects demonstrated all tested relations. One subject demonstrated the AD-B and BD-A relations but not the D-AB relations. One subject did not respond systematically during testing. The results of these experiments extend stimulus equivalence research to more complex cases.

Key words: stimulus equivalence, compound stimuli, hierarchical stimulus control, stimulus sets, stimulus interchangeability, key press, humans

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Stimulus equivalence is defined as the emergence of a specific set of untrained stimulus relations (reflexivity, symmetry, and transitivity) when humans are taught a number of interrelated conditional discriminations (Sidman & Tailby, 1982). This area of research has attracted much attention lately because stimulus equivalence provides a framework from which one can begin to understand some aspects of complex human behavior. In particular, the formation of stimulus equivalence classes may be important for accounts of symbolic behavior (e.g., Hayes, 1990), language (e.g., Devany, Hayes, & Nelson, 1986; Green, Sigurdardottir, & Saunders, 1991; Sidman, 1986), and humans' ability to respond appropriately in new situations (e.g., Sidman & Tailby, 1982; Spradlin & Saunders, 1984). Further, research has demonstrated that stimuli can acquire a number of functions simply by virtue of their membership in equivalence classes (Gatch & Osborne, 1989; Green et al., 1991; Hayes, Kohlenberg, & Hayes, 1991; Kohlenberg, Hayes, & Hayes, 1991; Lazar, 1977; Lazar & Kotlarchyk, 1986; Wulfert & Hayes, 1988).

To date, research on stimulus equivalence has been largely restricted to an analysis of dyadic relations among unitary stimuli. Two exceptions are studies by Stromer and Stromer (1990a, 1990b), who used complex sample stimuli in arbitrary match-to-sample training procedures. In the first study, they taught relations of the form AB-D and AC-E, then tested for emergent relations among all possible pairs of single stimuli (e.g., A-B, D-B, B-C, B-E, and D-E). These emergent relations were demonstrated in 14 of 18 subjects. In the second study, they trained the relations A-C, B-D, and AB-E, then tested for relations among all possible pairs of single stimuli (e.g., A-D, B-C, C-E, and D-E). These relations were demonstrated in 13 of 14 subjects. The results of these studies showed that human subjects can learn conditional discriminations using compound sample stimuli and respond in systematic ways in testing to elements of the compound samples used in training. However, these studies investigated only the emergence of symmetrical and transitive relations when subjects were trained to match unitary comparisons to compound samples. Given suitable

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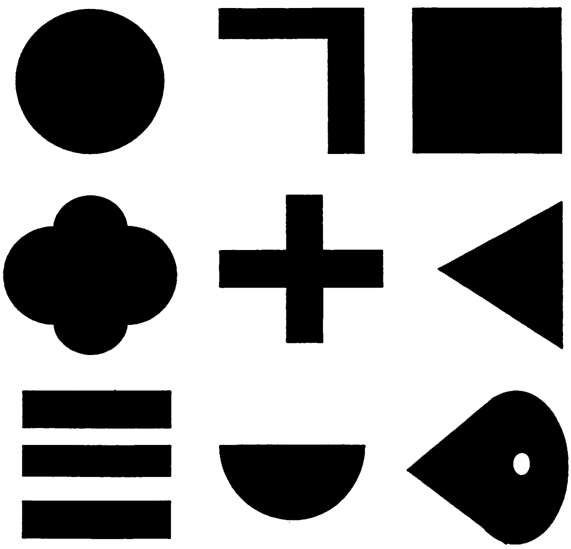

Fig. 1. Stimuli used in Experiment 1.

training procedures, it should be possible to test for additional emergent relations after training subjects to match unitary comparisons to compound samples. The present study was designed to test this possibility.

In the present experiments, we trained subjects to match unitary comparisons to compound sample stimuli. Specifically, nine relations of the form AB-C were trained. This permits the emergence of nine AC-B relations and nine BC-A relations. If subjects were to demonstrate these emergent relations, it would extend the range of stimulus relations shown to emerge in stimulus equivalence research. In addition, it would raise interesting questions about the nature of the stimulus control operating in these experimental arrangements.

EXPERIMENT 1

METHOD

Subjects

Subjects were 11 undergraduates (6 females and 5 males, aged 18 to 24 years) enrolled in introductory psychology courses at the University of New Mexico. They were recruited through in-class and bulletin board announcements. They received course credit for their participation. At the beginning of the experiment, the general procedures were explained to the subjects, and they read and signed a statement of informed consent. After completing the experiment, subjects were fully debriefed. All procedures were approved by the Human Research Review Committee of the University of New Mexico.

Apparatus and Stimuli

An IBM® personal computer with a 19-cm monochrome (green on black) display was used to present stimuli and record data during the experiment. Each subject was seated before the personal computer in a small experiment room with a two-way mirror for observation of the subject.

The stimuli were nine abstract forms designated randomly for each subject as A1, B1, C1, A2, B2, C2, A3, B3, and C3 (see Figure 1). The alphanumeric designations are for purposes of description only and were never shown to the subjects. Each stimulus occupied a 4-cm by 5-cm space on the display.

Procedure

Nine conditional discriminations involving compound samples and unitary comparisons were trained, and 18 emergent relations were tested. Both training and testing used arbitrary match-to-sample procedures. The compound sample appeared at the top center of the screen, followed 2 s later by the three comparisons at the bottom right, bottom left, and bottom center of the screen. Compound samples were pairs of stimuli presented side by side on the screen. The elements comprising the sample compounds were randomly assigned to the left and right positions for each trial. For each trial, the comparisons were randomly assigned to the left, middle, or right position at the bottom of the screen. The subject selected one of the comparisons by pressing the "1," "2," or "3" key on the computer keyboard to select the left, middle, or right comparison, respectively. After a key was pressed, the screen cleared and, during training, responses to the correct comparison produced the word "correct" on the monitor, and other choices produced the word "wrong." The screen cleared again after a 5-s delay. After a 2-s intertrial interval, a new trial began. Once the subject met the training criterion, feedback was gradually faded over 20 trials (e.g., Correc., Corr. . . , ... , ... , . . .) to reduce the discriminability between training and testing. During testing, no feedback appeared.

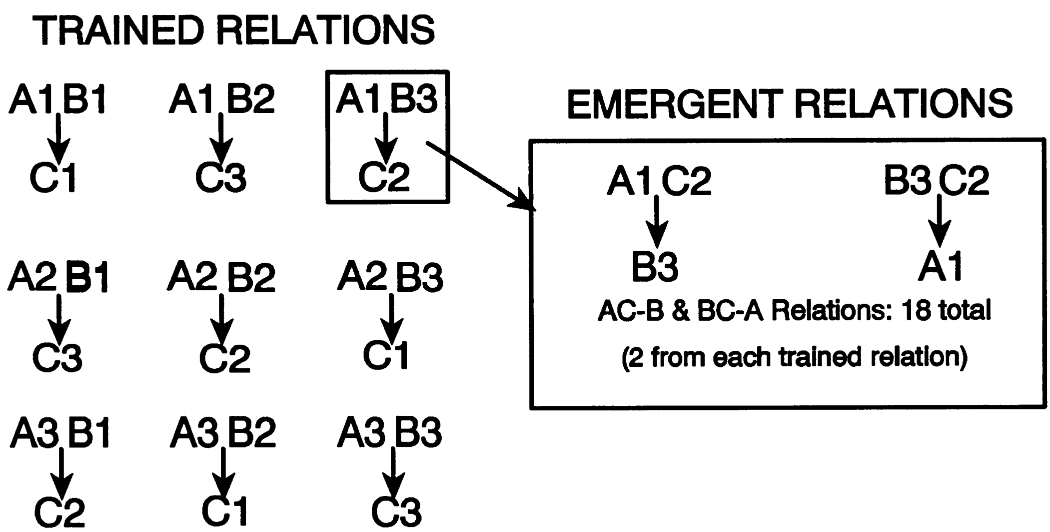

Fig. 2. Relations trained in Experiment 1 (left) and two examples of possibly emergent relations that exemplify the type tested in the experiment (in box on right).

Subjects were given the following instructions to read:

> When the experiment begins, you will see sets of symbols appear on the screen. They will appear at the top of the screen, and at the bottom of the screen on the left, middle, and right. Your task is to choose the correct symbol at the bottom of the screen by pressing the "1," "2," or "3" key on the keyboard to select the left, middle, or right symbol. Early in the experiment you will get feedback on every choice. Later in the experiment you will not get feedback every time. However, there is always a correct answer. During the first part of the experiment the task will be easy, and it is tempting not to pay attention. However, the experiment will increase in difficulty, and choosing the correct symbols in the latter parts of the experiment will depend on the knowledge you gain during the early parts of the experiment. To prevent impulsive responding, the computer will not accept choices for one second after the symbols appear. Do you have any questions?

After reading the instructions, the subject was asked to explain the instructions to the experimenter. If unable to do so, he or she was required to read the instructions again until he or she was able to explain the instructions. After mastering the instructions, the subject began the experiment.

The nine AB-C relations shown in Figure 2 were trained until the subject reached a training criterion of 98 correct out of 100 consecutive trials. On all training trials, the comparison stimuli were C1, C2, and C3. The nine baseline AB-C relations were such that no stimulus was associated exclusively with any other stimulus. Thus, this design prevented subjects from responding correctly based upon only one element of the compound samples. For example, if a subject were to respond correctly to the training relation A1B1-C1 based upon only the presence of B1, then his or her response to the trial A2B1-C3 would necessarily be incorrect, because control by B1 would in this case require a response to C1.

The baseline relations were presented in blocks of nine trial types, each consisting of one compound sample and its appropriate comparison array. Within each block of training trials, trial types were presented in a random order. Once these baseline relations were established, we tested subjects for nine AC-B and nine BC-A relations. The trial types for these tests are shown in Table 1.

During testing, 20 blocks of these 18 trial types were presented. Within each block, trial types were presented in a random order. As was the case in training, responding only to elements of the stimulus compounds would necessarily lead to a majority of incorrect responses. For example, if a subject's choice of B1 in the presence of A1C1 were controlled by C1 alone, then the subject would also select B1 in the presence of A2C1, which is an in-

Table 1

Trial types presented during testing in Experiment 1.

Sample	Comparisons		
	Correct	Incorrect	Incorrect
A1C1	B1	B2	B3
B1C1	A1	A2	A3
A1C3	B2	B1	B3
B2C3	A1	A2	A3
A1C2	B3	B1	B2
B3C2	A1	A2	A3
A2C3	B1	B2	B3
B1C3	A2	A1	A3
A2C2	B2	B1	B3
B2C2	A2	A1	A3
A2C1	B3	B1	B2
B3C1	A2	A1	A3
A3C2	B1	B2	B3
B1C2	A3	A1	A2
A3C1	B2	B1	B3
B2C1	A3	A1	A2
A3C3	B3	B1	B2
B3C3	A3	A1	A2

Table 2

Number of trials and time (in hours and minutes) required to reach training criterion in Experiment 1.

Subject	Training time	Training trials
BB	2:14	793
	1:28	566
DW	0:49	324
GM	0:32	213
JD	1:08	448
LC	3:11	1,009
	0:27	174
LF	2:38	1,031
	0:21	150
LP	1:11	518
RG	1:30	620
SK	1:17	378
TC	1:09	422
TT	1:55	653

correct selection (see Table 1). Thus, correct responding during testing must be controlled by both elements of the sample in conjunction with the correct comparison.

The experiment ended when subjects completed the testing phase of the experiment. All sessions were limited to 4 hr in duration.

Results and Discussion

Except for Subjects LF, LC, and BB, who required two sessions, all of the subjects completed the experiment in one session. Number of training trials required to reach criterion and time required to reach criterion are shown in Table 2. Test data for all subjects, graphed as percentage of trials correct over 18-trial blocks, are shown in Figures 3 and 4. All subjects maintained a high level of accuracy throughout testing. Subject BB terminated the experiment after completing seven blocks of testing trials (126 trials), but performed at near-perfect accuracy during the completed test trials. These results show that all 11 subjects clearly showed the emergence of AC-B and BC-A relations.

Although these results suggest the emergence of previously unreported relations among stimuli, at least two questions arise. The first is whether equivalence relations also emerged from these experimental arrangements. The second is whether these results could be explained by simple (rather than conditional) stimulus control. It is possible that the subjects were responding to nine different ABC stimulus compounds as individual discriminative stimuli rather than the AB compound samples exerting conditional control over the discriminative functions of the C comparisons. Thus, the results of Experiment 1 may have resulted from simple discriminative control by the nine ABC compounds that were simply spatially rearranged. This interpretation of the results is analogous to that suggested by Bush, Sidman, and DeRose (1989) and Lynch and Green (1991) in response to the issue of whether Bush et al. had demonstrated contextual (higher order) control of equivalence classes. These investigators have argued that the test for conditional or higher order stimulus control is the demonstration of the independent functions of the putative conditional and discriminative stimuli. Experiment 2 was designed to address both issues.

We reasoned that if symmetry and transitivity emerge from the baseline conditional discriminations established using the procedures of Experiment 1, it could be argued that stimulus equivalence does result from these procedures. Moreover, the emergence of transitive relations would demonstrate that conditional stimulus control can result from these procedures.

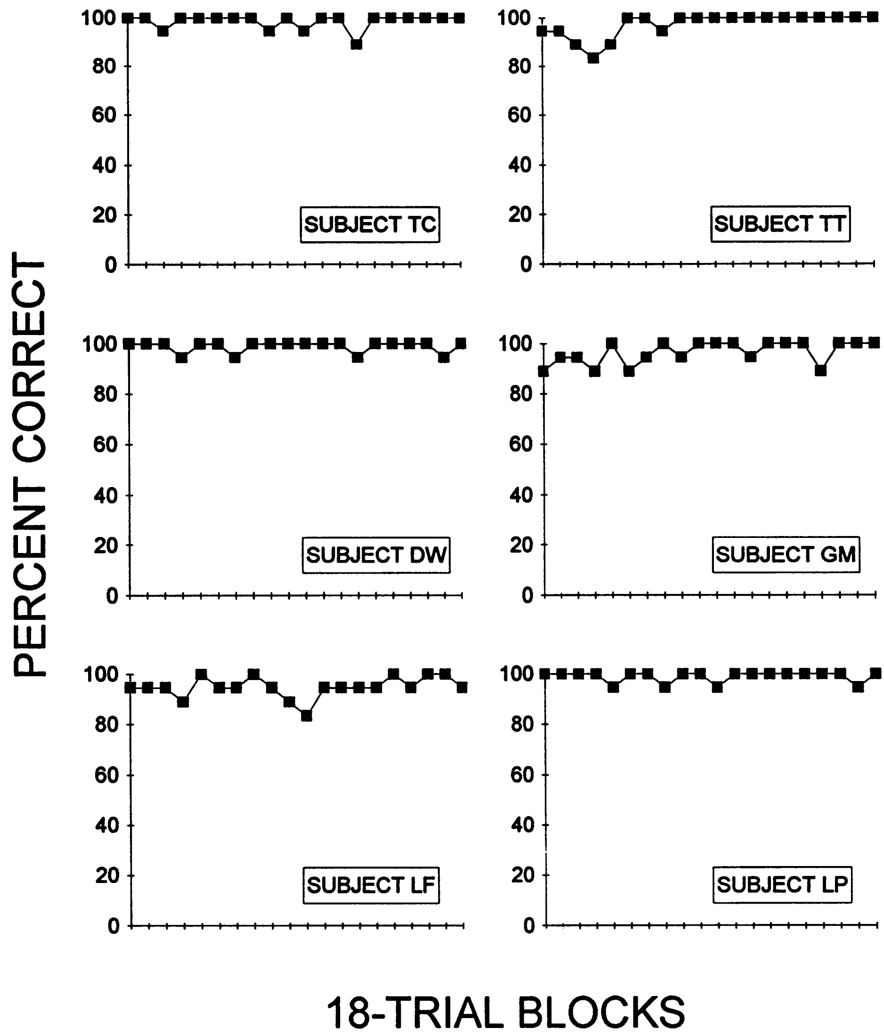

Fig. 3. Percentage "correct" (i.e., that conformed to expected emergent relations) out of 18 over 18-trial blocks for 6 subjects during the testing phase of Experiment 1.

EXPERIMENT 2

Two groups of subjects participated in Experiment 2. One group was taught the nine AB-C relations described in Experiment 1 and was tested for nine symmetrical (C-AB) relations. The other group received the same training, with the addition of three C-D relations, and was then tested for the emergence of nine transitive (AB-D) relations.

METHOD

Subjects and Apparatus

Twelve undergraduates, recruited and compensated as described in Experiment 1, participated in the experiment. Six of these subjects (4 females and 2 males, 20 to 23 years old) were assigned to the symmetry group, and 6 (3 females and 3 males, 19 to 27 years old) were assigned to the transitivity group. The apparatus and setting were the same as in Experiment 1 with the addition of three stimuli designated as D1, D2, and D3 (see Figure 5).

Procedure

The general procedures were the same as in Experiment 1. Subjects in the symmetry group were taught the nine AB-C relations

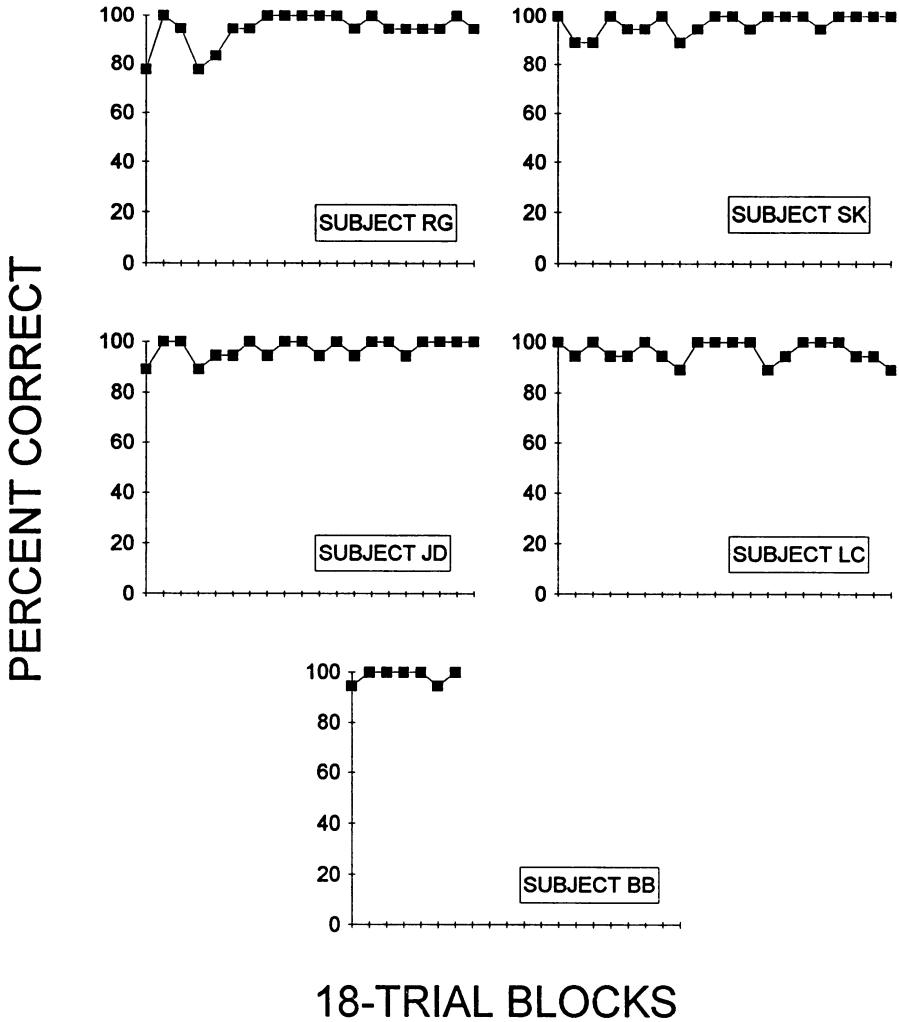

Fig. 4. Percentage "correct" out of 18 over 18-trial blocks for 5 subjects during the testing phase of Experiment 1.

shown in Figure 6. Subjects in the transitivity group were taught the same nine AB-C relations and three CD relations (C1D1, C2D2, and C3D3; see Figure 6). For CD training trials, the sample (C1, C2, or C3) appeared at the top center of the screen and the comparisons were always D1, D2, and D3. Training for all subjects continued until they reached a criterion of 70 of 72 consecutive trials correct.

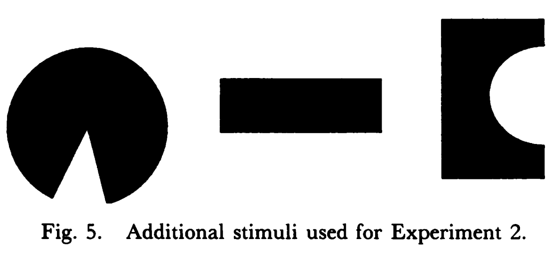

Fig. 5. Additional stimuli used for Experiment 2.

Subjects in the symmetry group were then tested for nine symmetrical C-AB relations. These nine trial types are shown in Table 3. Subjects in the transitivity group were tested for nine transitive AB-D relations. The trial types used for transitivity tests are also shown in Table 3. All subjects received 30 blocks of nine trials each during testing, for a total of 270 trials.

Results and Discussion

Number of training trials to criterion is shown for subjects in both groups in Table 4. Test data for subjects in the symmetry group, graphed as percentage of trials correct over

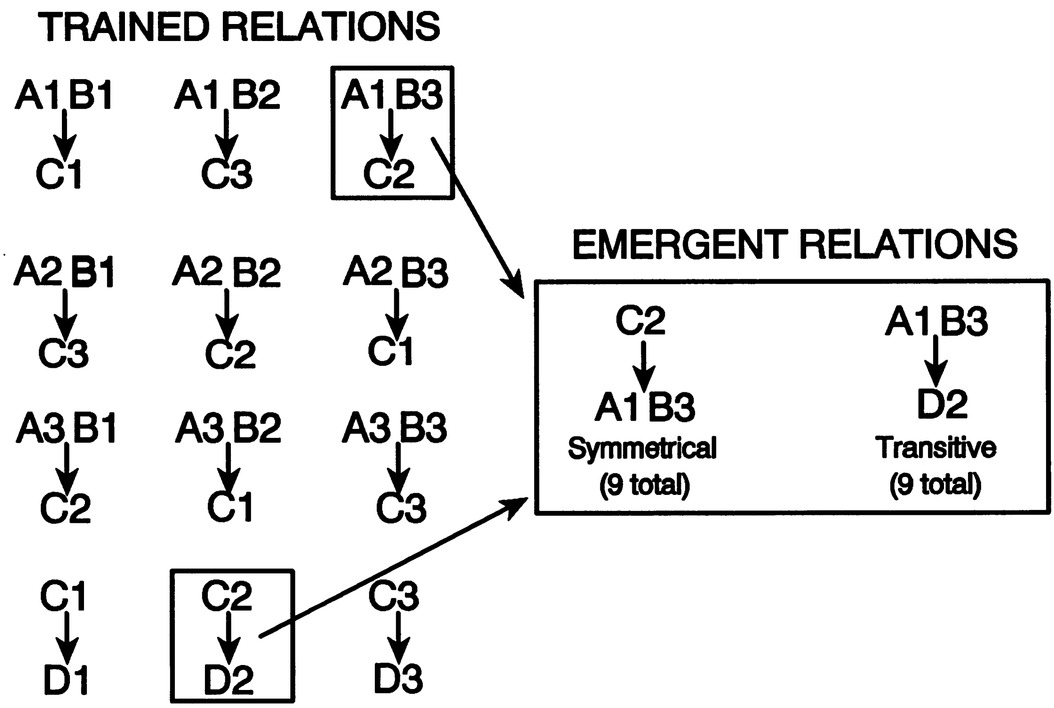

Fig. 6. Relations trained in Experiment 2 (left) and examples of tests for symmetry and transitivity (box at right) that occurred following training.

nine trial blocks, are shown in Figure 7. Five subjects (RV, MH, LP, ME, and MB) maintained near-perfect performance throughout testing. Subject GP responded at chance accuracy for 219 trials, then terminated the experiment. Thus, 5 of 6 subjects clearly demonstrated the emergence of symmetrical C-AB relations.

Test data for subjects in the transitivity group, graphed as percentage of trials correct over nine trial blocks, are shown in Figure 8. With the exception of Subject DY, all subjects maintained near-perfect accuracy during most of testing. Subject DY performed at 44.4% (four of nine) and 88.8% (eight of nine) accuracy for Trial Blocks 1 and 2, respectively, then maintained near-perfect performance during the rest of the experiment. Subject DF maintained high levels of accuracy during testing, but terminated the experiment after completing 26 blocks of testing trials. These results clearly show the emergence of transitive AB-D relations in all subjects.

The results of this experiment indicate that symmetry and transitivity emerged from conditional discrimination training using compound samples and unitary comparisons. These

Table 3

Trial types presented during testing in Experiment 2.

	Comparisons		
Sample	Correct	Incorrect	Incorrect
Symmetry tests			
C1	A1B1	A2B2	A3B3
C3	A1B2	A2B3	A3B1
C2	A1B3	A2B1	A3B2
C3	A2B1	A1B3	A3B2
C2	A2B2	A1B1	A3B3
C1	A2B3	A1B2	A3B1
C2	A3B1	A1B2	A2B3
C1	A3B2	A1B3	A2B1
C3	A3B3	A1B1	A2B2
Transitivity tests			
A1B1	D1	D2	D3
A1B2	D3	D1	D2
A1B3	D2	D1	D3
A2B1	D3	D1	D2
A2B2	D2	D1	D3
A2B3	D1	D2	D3
A3B1	D2	D1	D3
A3B2	D1	D2	D3
A3B3	D3	D1	D2

Table 4

Number of trials required to reach training criterion in Experiment 2.

Subject	Training trials
Symmetry group	
GP	219
PB	245
MB	390
ME	221
MH	238
RV	273
Transitivity group	
DF	592
DY	648
ES	182
SL	252
RC	766
PM	213

findings show that the conditional discrimination training used in Experiment 1 can lead to the emergence of stimulus equivalence as well as those relations obtained in Experiment 1. Thus, the relations that can emerge from conditional discrimination arrangements do not appear to be restricted to reflexivity, symmetry, and transitivity. Moreover, the results of the transitivity tests in this experiment support the conclusion that the baseline relations trained in Experiment 1 met the conditions of conditional stimulus control as outlined by Sidman (1986). That is, subjects' responses on these test trials showed that the AB compounds did, in fact, control choices of the appropriate D stimuli. Because the D stimuli had never before been associated directly with the AB compounds, there was no opportunity for the stimuli to act as unitary ABD compounds that

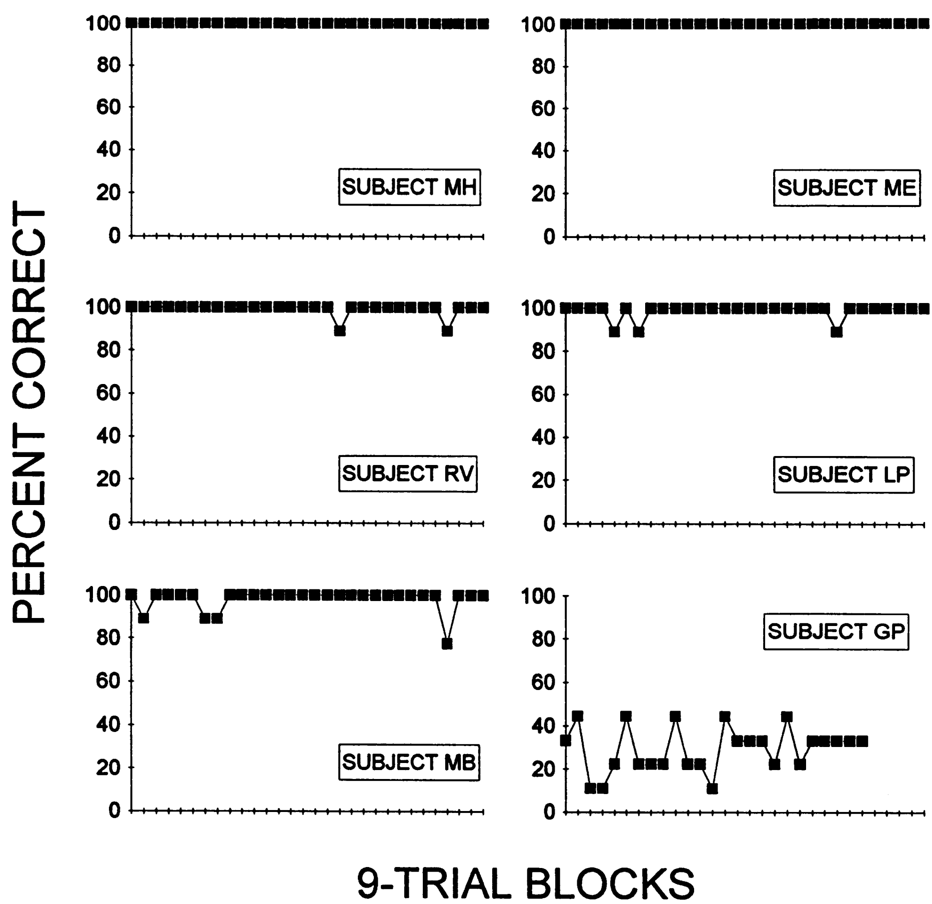

Fig. 7. Percentage of choices consistent with symmetrical stimulus control during nine-trial test blocks for 6 subjects in Experiment 2.

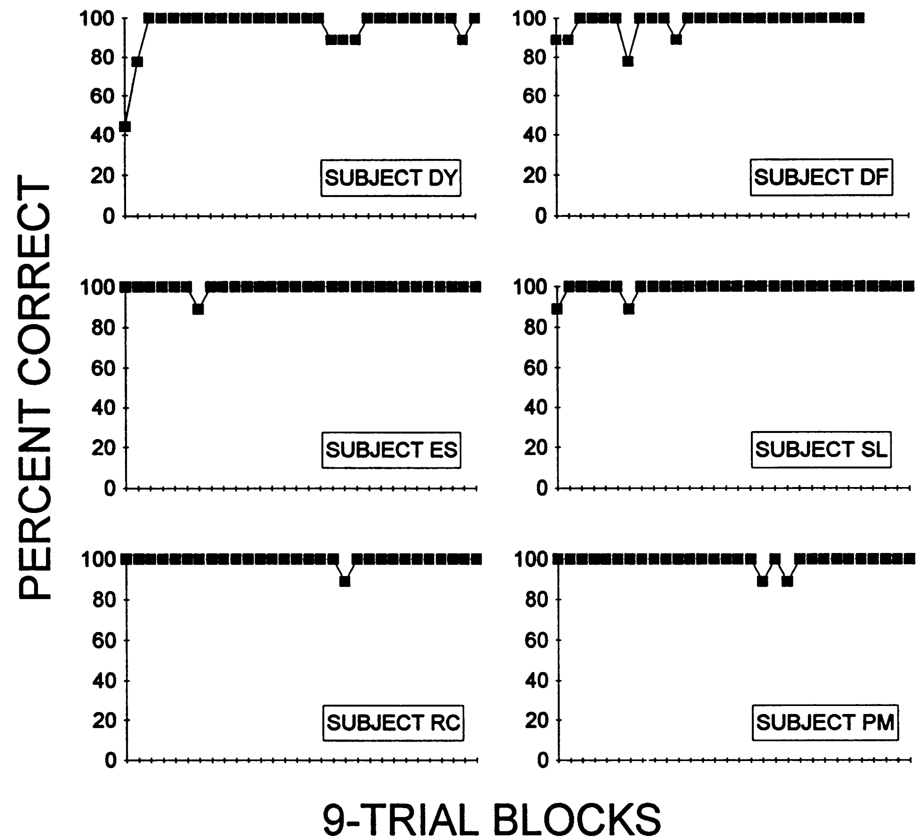

Fig. 8. Percentage of choices consistent with transitive stimulus control during nine-trial test blocks for the other 6 subjects in Experiment 2.

could then exert simple discriminative control over the subjects' behavior.

Figure 9 presents additional stimulus relations that may be derived from conditional discrimination training with compound samples and unitary comparisons. In Experiment 3, we tested for these equivalence (D-AB) relations, as well as AD-B and BD-A relations. We chose these relations for two reasons. First, they would extend the range of demonstrated derived relations that are possible with these training procedures. Second, they would provide more convincing evidence that the emergent relations are not the result of simple discriminative control. The logic here is that because the D stimuli have never before been associated with the AB compounds before testing, and the D stimuli now function as sample stimuli or elements of sample compounds, it is not possible to explain the emergence of these relations in terms of simple discriminative control. This is the same logic that applies to tests for stimulus equivalence using unitary stimuli (e.g., Lynch & Green, 1991). Although this cannot demonstrate conclusively that the relations obtained in Experiment 1 were a result of conditional stimulus control, it lends some support to this possibility.

EXPERIMENT 3

Experiment 3 tested for the emergence of equivalence (D-AB) as well as AD-B and BD-A relations after subjects were taught nine AB-C and three C-D relations.

METHOD

Subjects and Apparatus

Five subjects (1 female and 4 males, 20 to 22 years old), recruited and compensated as described in Experiments 1 and 2, participated in the experiment. The apparatus and setting were identical to those in Experiment 2.

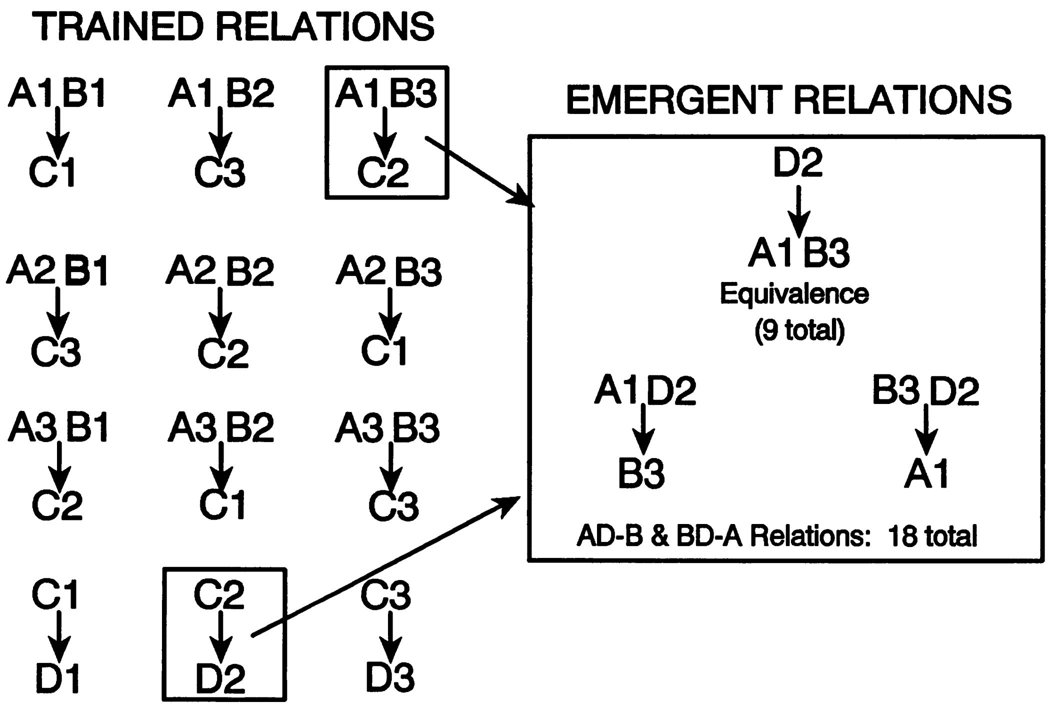

Fig. 9. Relations trained in Experiment 3 (left) and examples of the types of potentially emergent relations tested for (box at right).

Procedure

The general procedure was the same as the procedures used in Experiments 1 and 2. Subjects were taught the nine AB-C relations shown in Figure 9 and three C-D relations (C1D1, C2D2, and C3D3). These relations were presented in randomized blocks of 12 trials each until subjects met a criterion of 70 of 72 consecutive trials correct. Testing was conducted in two phases. Subjects were first tested for the emergence of nine D-AB relations. The trial types used to test for these relations are shown in Table 5. Ten blocks of these nine trial types were presented. Subjects were then tested for the emergence of nine AD-B and nine DB-A relations. The trial types used for these tests are also shown in Table 5. Subjects completed 10 blocks of these 18 trial types. Thus, subjects experienced a total of 270 test trials.

Results and Discussion

Number of training trials required to reach criterion is shown for all subjects in Table 6. Test data for all subjects, graphed as percentage of trials correct over 9- or 18-trial blocks, are shown in Figure 10. Three subjects (JC, ET, and JF) clearly demonstrated the emergence of both equivalence (D-AB) and AD-B and BD-A relations. One subject (WR) did not demonstrate equivalence, but showed indications of the emergence of AD-B and BD-A relations. Finally, 1 subject (AS) responded at about chance accuracy throughout tests for equivalence and AD-B and BD-A relations.

These results demonstrate the emergence of extraordinarily complex relations from compound-sample conditional discrimination procedures. Moreover, the results suggest that these emergent relations, as well as those from Experiments 1 and 2, cannot be explained by simple discriminative control by unitary compound stimuli. During test trials, subjects demonstrated AD-B and BD-A relations, although training trials were never conducted with AB and D stimuli present on the same trial. It appears, then, that the samples exerted conditional control over the subjects' behavior, at least as defined by Sidman (1986).

GENERAL DISCUSSION

The experiments described here examined emergent stimulus relations involving com-

Table 5

Trial types presented during testing in Experiment 3.

Sample	Comparisons Correct	Incorrect	Incorrect
Equivalence tests			
D1	A1B1	A2B2	A3B3
D3	A1B2	A2B3	A3B1
D2	A1B3	A2B1	A3B2
D3	A2B1	A1B3	A3B2
D2	A2B2	A1B1	A3B3
D1	A2B3	A1B2	A3B1
D2	A3B1	A1B2	A2B3
D1	A3B2	A1B3	A2B1
D3	A3B3	A1B1	A2B2
AD-B and BD-A tests			
A1D1	B1	B2	B3
B1D1	A1	A2	A3
A1D3	B2	B1	B3
B2D3	A1	A2	A3
A1D2	B3	B1	B2
B3D2	A1	A2	A3
A2D3	B1	B2	B3
B1D3	A2	A1	A3
A2D2	B2	B1	B3
B2D2	A2	A1	A3
A2D1	B3	B1	B2
B3D1	A2	A1	A3
A3D2	B1	B2	B3
B1D2	A3	A1	A2
A3D1	B2	B1	B3
B2D1	A3	A1	A2
A3D3	B3	B1	B2
B3D3	A3	A1	A2

Table 6

Number of trials required to reach training criterion in Experiment 3.

Subject	Training trials
AS	430
ET	798
JC	349
JF	593
WR	288

pound stimuli. In Experiment 1, subjects were taught nine AB-C relations and were then tested for nine AC-B relations and nine BC-A relations. Although the pattern of results across all subjects was consistent and clearly suggested the emergence of previously unreported relations, stimulus equivalence was not examined, and the possibility remained that the baseline relations were under simple discriminative rather than conditional control. Experiment 2 was designed to address these issues.

Two groups of subjects participated in Experiment 2. Subjects in the symmetry group were taught nine AB-C relations and were then tested for nine symmetrical (C-AB) relations. Subjects in the transitivity group were taught nine AB-C relations and three C-D relations and were then tested for nine transitive (AB-D) relations. Five of the 6 subjects in the symmetry group clearly showed the emergence of symmetrical stimulus control. All 6 subjects in the transitivity group showed the emergence of transitive stimulus control. These results provide support for the assertion that the subjects' behavior was under conditional (rather than simple) discriminative control. Nevertheless, because Experiments 1 and 2 used different training and testing procedures, claims about subjects' performances in Experiment 1 based on the results of Experiment 2 were inconclusive. Moreover, a number of relations other than those tested in Experiments 1 and 2 could emerge from the trained baseline relations. Therefore, a third experiment was conducted to address these two issues.

In Experiment 3, subjects were taught nine AB-C relations and three C-D relations and were then tested for the emergence of equivalence (D-AB) as well as AD-B and BD-A relations. Three of 5 subjects showed the emergence of all tested relations. One subject did not demonstrate equivalence but did demonstrate AD-B and BD-A relations. The remaining subject demonstrated neither.

There are two obvious limitations of the present study. Most notably, due to restricted duration of experimental sessions, each subject did not encounter all stimulus relations tested. Thus, one could argue that a single subject might not show the emergence of all relations tested in Experiments 1, 2, and 3. Further research is needed to address this issue.

Second, only 3 of the 5 subjects in Experiment 3 demonstrated both types of tested stimulus relations. Although the results of this experiment demonstrated the emergence of equivalence as well as AD-B and BD-A relations in some subjects, the sources of intersubject variability were not investigated. One possible cause is insufficient baseline training. Further research should investigate the variables responsible for this variability. Despite these limitations, the present experiments

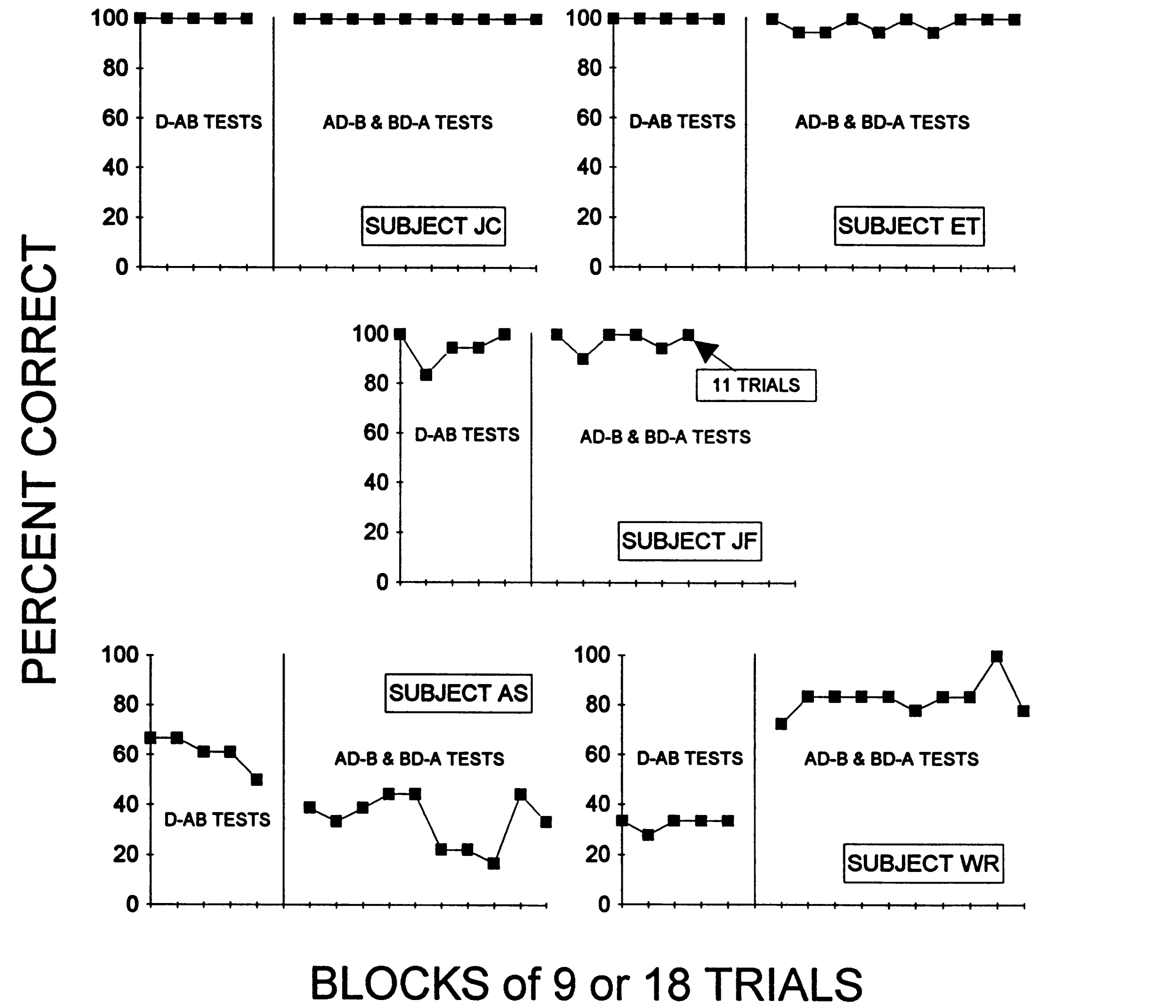

Fig. 10. Percentage of choices out of nine consistent with equivalence (leftmost five points in each graph) and percentage of choices out of 18 consistent with predicted emergent relations of the AD-B and BD-A types (remaining points) for the 5 subjects of Experiment 3.

demonstrate the emergence of previously unreported derived stimulus relations.

Apart from extending the range of relations that can emerge from conditional discrimination training, the present results raise some interesting conceptual questions. How, for example, should we describe the stimulus control exerted by the compound stimuli? The results of Experiments 2 and 3 show that the compound samples functioned as independent conditional stimuli. However, the results of Experiments 1 and 3 suggest that the compounds did not function as unitary stimuli. In these experiments, the elements of the compounds were separated and then combined with the related comparisons to exert independent stimulus control. Although the compound samples appear to be independent functional units, the elements of the compounds can also serve independent functions.

It could be argued that one of the elements of each compound sample functioned as a contextual stimulus for the conditional function of the other element. For example, in the baseline relations A1B1-C1, A2B1-C3, and A3B1-C2, A1 and A2 might have functioned as contextual stimuli for the conditional function of B1. Conversely, B1 might have functioned as a contextual stimulus for the conditional functions of the A stimuli. On what basis can we determine which element served a conditional function and which served a contextual function? Thomas and Schmidt (1989) discussed a similar problem in identifying conditional and discriminative functions in some conditional discrimination arrangements.

Moreover, the results of Experiments 1 and 3 show that both elements of the AB samples functioned independently as comparisons during test trials, indicating that they entered the equivalence classes. If these stimuli had, in fact, functioned as contextual stimuli during training, these results would contradict Sidman's (1986) assertion that contextual stimuli cannot enter equivalence classes. Additional research is needed to examine the nature of the functional relation between the elements that comprise compound stimuli.

As it stands, we are left with results that are difficult to interpret within existing accounts of stimulus equivalence. One way of describing the compound stimulus control observed in the present study is suggested by Stromer, McIlvane, and Serna (in press). They argue that what are called conditional discriminations in match-to-sample arrangements may actually be an example of simple discriminative control by compound stimuli with separable and substitutable elements. Subjects' performances during tests for emergent relations could then be explained in terms of discriminative control by such separable compounds. The present findings lend support to this account.

In addition, the results of the present experiments raise several other questions to be addressed by future research. For example, there are a number of possible stimulus relations that may emerge when subjects are taught to match single comparison stimuli to compound samples. Only a few were tested in the present study; the rest should be explored in future studies. In addition, more research concerning stimulus control by compound stimuli is needed (e.g., Stromer, McIlvane, Dube, & Mackay, 1993). Finally, future research should examine the relation between transfer of stimulus functions (Gatch & Osborne, 1989; Green et al., 1991; Hayes et al., 1991; Kohlenberg et al., 1991; Lazar, 1977; Lazar & Kotlarchyk, 1986; Wulfert & Hayes, 1988) and the relations that emerge when compound stimuli are used in conditional discrimination procedures.

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